Future of the US Refining Industry

*Between a Rock and a Hard Place*

(* or why declining supplies of heavy oil and climate legislation are bad news for the industry)

Presentation by

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Washington, DC

Panel on Western Hemisphere Heavy Oil Supplies & Refining

Energy Council
Center for Legislative Energy and Environmental Research (CLEER)
United States Energy Association
Take Aways

Challenges Facing US Refining Industry

• Declining Growth in Heavy Crude Volumes (at least in the near term)
• Environmental (i.e., Climate) Policies
• Economic Downturn and Subsequent Declining Product Demand
• Import Competition

And

Very Poorly Designed Environmental Control and Renewable Fuel Programs
Heavy Crude $ Discount to Light Crude

Source: EIA data, EPRINC Calculations
Heavy Crude % Discount to Light Crude

Source: EIA data
Light Heavy Spreads Declined

![Crude & Product Price Differentials Graph](#)

Source: EIA
Total Crude Production from Producers With Significant Heavy Crude Production

Source: EIA data
U.S. Heavy Crude and Oil Sands Sources to Shift

Source: EIA
Number of U.S. Refineries and Capacity

Source: EIA data
Total Gasoline Imports Share of Finished Motor Gasoline Product Supplied

Source: EIA data, EPRINC calculations
Western Europe Gasoline Export Growth

Source: EIA
Significant Shift from 2007 Outlook to 2009 Outlook

- **In 2007,**
  - Rising prices projected to ease in the long term with new supply
  - U.S. petroleum growth projected to continue; need for more refining capacity

- **But outlook from 2009 is dramatically different,**
  - Future prices are about double those seen in 2007
  - Demand flat

- **Policy changes another important factor**

*Source: EIA*
Golden Age to Dark Age?

Source: EIA
EIA W-M Base Case Petroleum Demand

Source: EIA Forecasts

Biodiesel
Ethanol
Total Crude and Refined Petroleum Product Supply*

Source: EIA Forecasts
US Refinery Capacity Utilization
1985-2009

Source: EIA data, EPRINC Calculations
EPA and EIA Allowance Price Forecasts

Source: EPA and EIA Forecasts
## Emission Allowances for Refiners Under W-M (Millions of Metric Tons of CO2 per Annum)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>2015</td>
<td>5,003</td>
<td>256</td>
<td>2,029</td>
<td>2,285</td>
<td>100</td>
<td>2,185</td>
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<tr>
<td>2020</td>
<td>5,056</td>
<td>250</td>
<td>1,980</td>
<td>2,230</td>
<td>101</td>
<td>2,129</td>
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<tr>
<td>2025</td>
<td>4,294</td>
<td>248</td>
<td>1,964</td>
<td>2,212</td>
<td>86</td>
<td>2,126</td>
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<tr>
<td>2030</td>
<td>3,533</td>
<td>249</td>
<td>1,973</td>
<td>2,222</td>
<td>0</td>
<td>2,222</td>
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</tbody>
</table>

Annual Compliance Cost for U.S. Refiners Under W-M (U.S. dollars in billions, carbon prices derived from EPA estimates)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost of Allowances to Cover Stationary Source Emissions</th>
<th>Cost of Allowances to Cover Product Combustion</th>
<th>Value of Allowances Allocated under W-M to U.S. Refiners</th>
<th>Total Cost of Allowances, Stationary Source and Product Combustion – net of 2% allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>——</td>
<td>——</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>2015</td>
<td>$3.3---$4.4</td>
<td>$26.4---$34.5</td>
<td>$1.30---$1.70</td>
<td>$28.4---$37.1</td>
</tr>
<tr>
<td>2020</td>
<td>$4.3---$5.5</td>
<td>$33.7---$43.5</td>
<td>$1.72---$2.22</td>
<td>$36.2---$46.8</td>
</tr>
<tr>
<td>2025</td>
<td>$5.4---$7.0</td>
<td>$42.6---$55.2</td>
<td>$1.86---$2.41</td>
<td>$46.1---$59.7</td>
</tr>
<tr>
<td>2030</td>
<td>$6.9---$8.9</td>
<td>$54.6---$70.7</td>
<td>$0</td>
<td>$61.5---$79.6</td>
</tr>
</tbody>
</table>

Stationary Emissions not Covered by Free Allowances

Source: EIA Data, EPRINC Calculations
Compliance Costs: US Refining Industry

Red area above yellow line represents “free” allowances allocated to refiners

- Cost of Allowances to Cover Product Combustion
- Cost of Allowances to Cover Stationary Source Emissions
- Total Cost of Allowances, Stationary Source and Product Combustion – net of 2% allocation
Effective Cost of Production: US Product Slate

Most complex refineries are on left, less complex on right. Complex refineries are generally larger.

$/bbl of throughput

Total capacity (cumulative left to right)

5 million b/d

10 million b/d

15 million b/d

*Some lubricant and small niche refineries have been excluded.
Source: EPRINC calculations

Source: EPRINC Calculations from OJG and proprietary refinery data sets of complexity, product slate valuations, and location. Product slate standardized to common EPRINC product/cost value index.
U.S. Refiners' Future Cost of Production
(2015 - 2030)

Stationary Emission Costs and Potential Capacity Losses 2015-2030


Projected Worldwide Refining Capacity Additions

Source: IEA Forecasts, EPRINC Calculations
## Some Planned Refining Capacity Additions by Locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Planned Completion Date</th>
<th>Net Addition to Capacity (thousand b/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>India - Jamnagar Export Refinery</td>
<td>2009</td>
<td>580</td>
</tr>
<tr>
<td>China</td>
<td>2014</td>
<td>5,600*</td>
</tr>
<tr>
<td>Saudi Arabia - Ras Tanura</td>
<td>2012</td>
<td>400</td>
</tr>
<tr>
<td>Saudi Arabia - Jubail</td>
<td>2013</td>
<td>400</td>
</tr>
<tr>
<td>Saudi Arabia - Yanbu Export Refinery</td>
<td>2014</td>
<td>400</td>
</tr>
<tr>
<td>Abu Dhabi - Ruwais</td>
<td>2014</td>
<td>400</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td><strong>7,780</strong></td>
</tr>
</tbody>
</table>

Source: EPRINC Calculations
Refined Product Gross Margins

Source: EIA Data, EPRINC Calculations
EISA ’07 Renewable Fuels Standard

Source: DOE, EIA Data and June 2009 STEO. Blend wall assumes projected 2009 gasoline consumption found in the June 2009 EIA STEO.
Retail Fuel Prices

*Price is per gallon of gasoline equivalent (BTU basis), according to DOE conversion standards: 1 Gallon of Gasoline = 1.333 gallons of E85 and 0.904 gallons of diesel.

Source: DOE Data
## Energy Subsidies Not Related to Electricity Production

<table>
<thead>
<tr>
<th>Category</th>
<th>Fuel Consumption (Quadrillion BTU)</th>
<th>FY 2007 Subsidy and Support (million 2007 dollars)</th>
<th>Subsidy (dollars per Million BTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>1.93</td>
<td>78</td>
<td>0.04</td>
</tr>
<tr>
<td>Refined Coal</td>
<td>0.16</td>
<td>214</td>
<td>1.35</td>
</tr>
<tr>
<td>Natural Gas and Petroleum Liquids</td>
<td>55.78</td>
<td>1921</td>
<td>0.03</td>
</tr>
<tr>
<td>Ethanol/Biofuels</td>
<td>0.57</td>
<td>3249</td>
<td>5.72</td>
</tr>
<tr>
<td>Geothermal</td>
<td>0.04</td>
<td>1</td>
<td>0.02</td>
</tr>
<tr>
<td>Solar</td>
<td>0.07</td>
<td>360</td>
<td>2.82</td>
</tr>
<tr>
<td>Other Renewables</td>
<td>2.5</td>
<td>184</td>
<td>0.14</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>*</td>
<td>230</td>
<td>NM</td>
</tr>
<tr>
<td>Total Fuel Specific</td>
<td>60.95</td>
<td>6237</td>
<td>0.1</td>
</tr>
<tr>
<td>Total Non-Fuel Specific</td>
<td>NM</td>
<td>3597</td>
<td>NM</td>
</tr>
<tr>
<td>Total End-Use and Non-Electricity</td>
<td>NM</td>
<td>9834</td>
<td>NM</td>
</tr>
</tbody>
</table>

Source: EIA Data
FFVs and E85 Usage

Source: EIA Data, DOE Data, EPRINC Calculations
The Blend Wall in a low RBOB World

Estimated all-in cost for ethanol: corn + operating costs + capital costs

Price difference between ethanol and RBOB

After serving its role as an oxygenate, ethanol must compete directly with gasoline

Ethanol loses significant value as it moves into E85

Falling values for ethanol will be mirrored by rising values for RINs

Blender's Credit: $0.45/gallon

Estimated all-in cost for ethanol: corn + operating costs + capital costs

Price difference between ethanol and RBOB

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Blender's Credit: $0.45/gallon
EIA AEO 2010 Biofuels Projection

- “Biofuels grow, but fall short of the 36 billion gallon RFS target in 2022, exceed it in 2035.”
- Richard Newell, EIA, at SAIS, December, 2009
The RFS Already Maximizes U.S. Low-GHG Biofuel Use Through 2025

- The 2008 AEO & a 2008 DOE Policy Analysis Office study project that RFS2 cellulosic biofuel waivers will be required through 2030 (AEO) or 2025 (Policy Analysis Office). Since then, the recession has further delayed investment.

Total = 101.605 Quadrillion Btu

- Petroleum 40%
- Nuclear Electric Power 8%
- Natural Gas 23%
- Coal 22%
- Renewable Energy 7%
- Total = 6.830 Quadrillion Btu
  - Solar Energy 1%
  - Hydroelectric 36%
  - Geothermal Energy 5%
  - Biomass 53%
  - Wind Energy 5%

Note: Sum of components may not equal 100 percent due to independent rounding.
## Lifecycle GHG Emissions

### Table 1. Draft Lifecycle GHG Emission Reduction Results For Different Time Horizon And Discount Rate Approaches.

<table>
<thead>
<tr>
<th>Fuel Pathway</th>
<th>100 year, 2% Discount Rate</th>
<th>30 year, 0% Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Ethanol (Natural Gas Dry Mill)</td>
<td>-16%</td>
<td>+5%</td>
</tr>
<tr>
<td>Corn Ethanol (Best Case Natural Gas Dry Mill)²</td>
<td>-39%</td>
<td>-18%</td>
</tr>
<tr>
<td>Corn Ethanol (Coal Dry Mill)</td>
<td>+13%</td>
<td>+34%</td>
</tr>
<tr>
<td>Corn Ethanol (Biomass Dry Mill)</td>
<td>-39%</td>
<td>-18%</td>
</tr>
<tr>
<td>Corn Ethanol (Biomass Dry Mill with Combined Heat and Power)</td>
<td>-47%</td>
<td>-26%</td>
</tr>
<tr>
<td>Soy-Based Biodiesel</td>
<td>-22%</td>
<td>+4%</td>
</tr>
<tr>
<td>Waste Grease Biodiesel</td>
<td>-80%</td>
<td>-80%</td>
</tr>
<tr>
<td>Sugarcane Ethanol</td>
<td>-44%</td>
<td>-26%</td>
</tr>
<tr>
<td>Switchgrass Ethanol</td>
<td>-128%</td>
<td>-124%</td>
</tr>
<tr>
<td>Corn Stover Ethanol</td>
<td>-115%</td>
<td>-116%</td>
</tr>
</tbody>
</table>

GHG Well to Wheels – CA ULSD

Source: Detailed California-Modified GREET Pathway for Ultra Low Sulfur Diesel (ULSD) from Average Crude Refined in California, CARB, Feb 28 2009
Upstream GHG Emissions by Feedstock

How the LCFS is Met in 2030

Approx. 275 million tonnes of CO₂ equivalent credits are required by 2030.

- Cellulosic ethanol: 54%
- Sugar ethanol: 4%
- Corn Ethanol: 3%
- BTL: 22%
- Biodiesel: 1%
- PHEV electricity: 1%
- Reductions from refining and upstream: 15%
Alberta Oil Sands – With and Without LCFS

Reference case 2025

Canada

3.4 mbpd

Mexico

0.6 mbpd

United States

2.0 mbpd

LCFS case 2025

Canada

0.7 mbpd

Mexico

1.2 mbpd

United States

0.6 mbpd